Travel Demand Modeling
Frequently Asked Questions

What is a travel demand model?

A travel demand model (TDM) is a tool used to make traffic forecasts, to test alternative transportation concepts, and to evaluate transportation systems. TDMs are built using a specialized process based on mathematical equations and intensive data collection. TDMs use special software such as TransCAD or MinUTP along with sets of programs that comprise the actual traffic model. A typical TDM will have 10-100 input files and several output files.

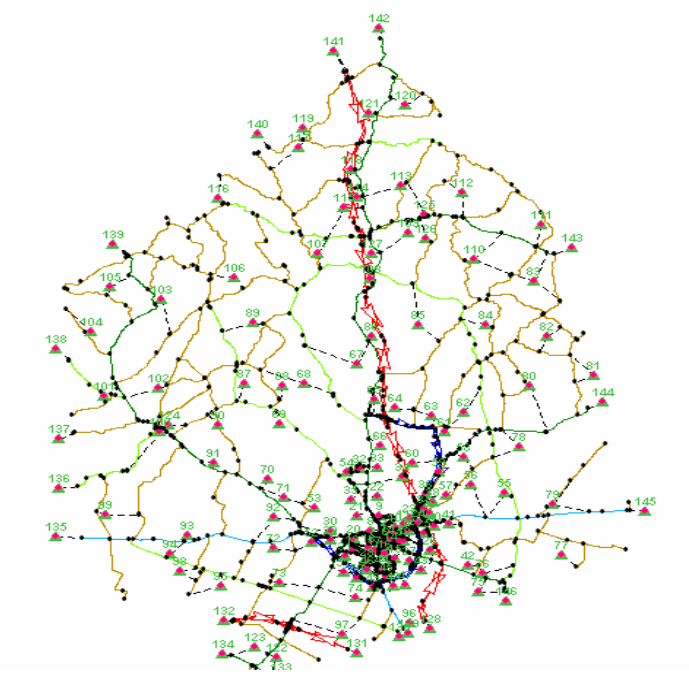
Is a travel demand model the same thing as a traffic simulation model?

No or at least not usually. Traffic simulation models – such as CORSIM or SYNCHRO – are used to assess detailed operational questions on urban corridors or very small urban areas. They require exhaustive information about the traffic signals, parking conditions, access points and require accurate turning movement data. Sometimes, the network from a TDM is used to build a traffic simulation model network. FHWA is sponsoring research that is attempting to merge traffic demand modeling and traffic simulation modeling. The project is called TRANSIMS and is expected to have a commercial product in the next five years. TRANSIMS is much more data intensive than current state-of-the-art traffic demand modeling and requires more computing power than typical desktop units of today.

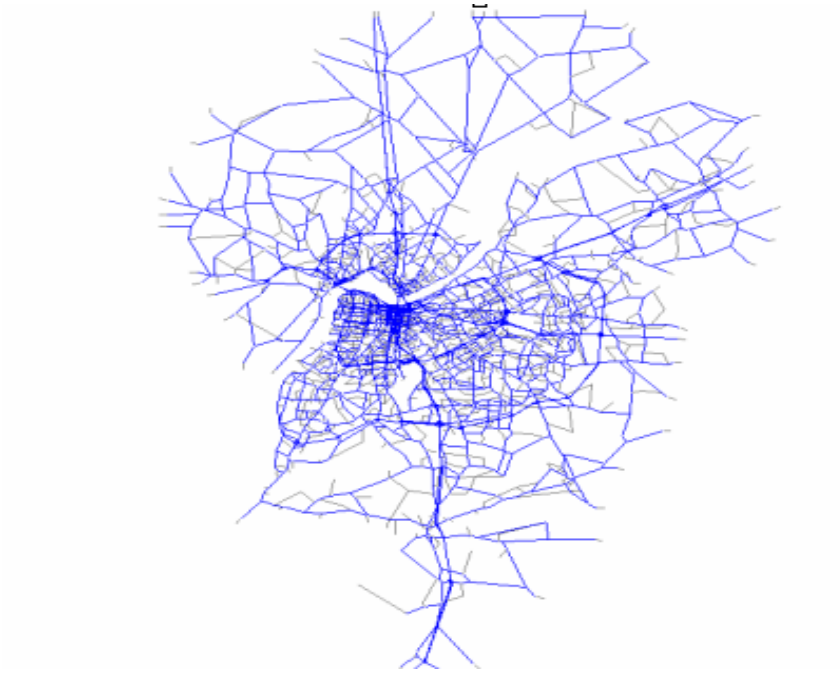
How are travel demand models used ?

The Kentucky Transportation Cabinet uses TDMs for traffic forecasting, plan development, air quality analysis and special studies. Some of the types of TDMs are:

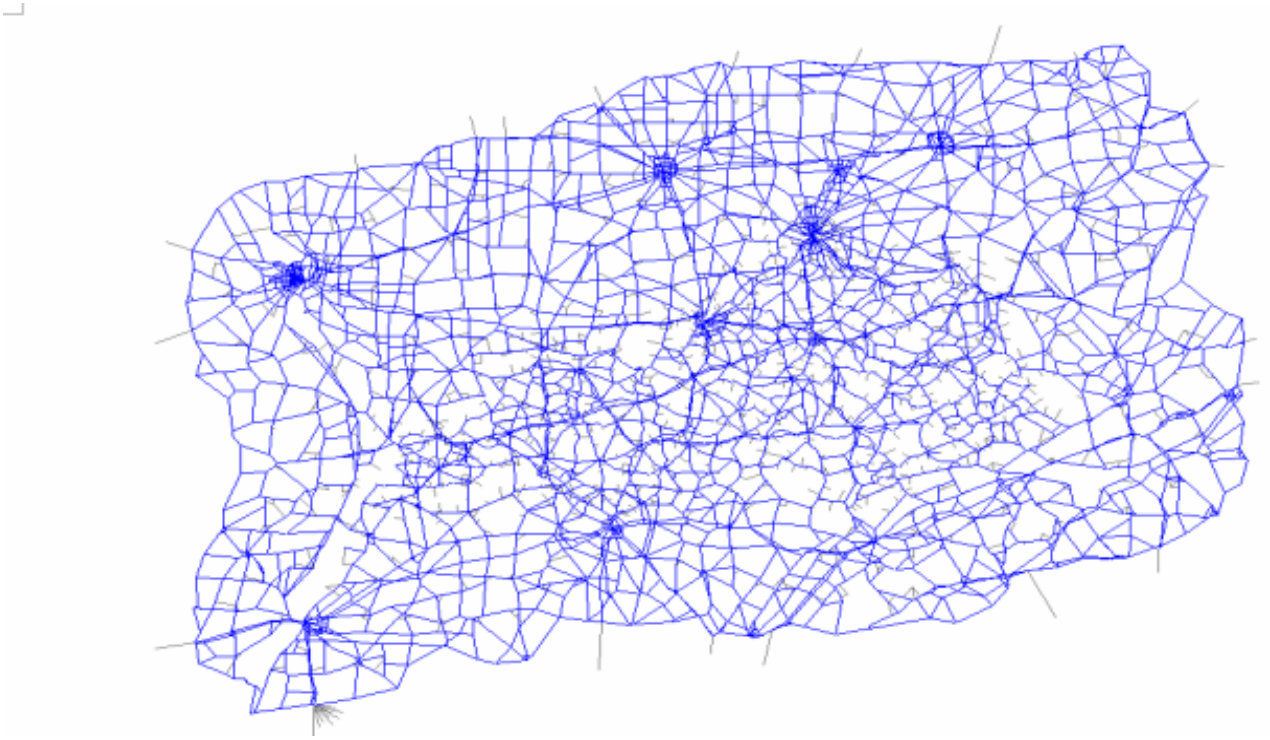
- **County-level Models** for air quality conformity analysis. Models have been developed for Marshall County, Graves County and Scott County. These TDMs can be used to calculate county –level vehicle miles traveled (VMT) for new roads. That county-level VMT can be compared to base condition VMT to see if the new road has an adverse impact on county-level emissions. These models can also be used for project development. Typically, the development time and dedicated data collection effort for these models is less than for other models. One of these models can be built in four months. The network and TAZ locations for the Scott County model is shown below:



- **MPO models** for KIPDA, OKI, Lexington and Owensboro (owned and operated by the MPOs) are used for traffic forecasting, plan development, air quality analysis and special studies. MPO TDMs can be very complex and may have a front end that includes land use modeling and formal interaction with the area comprehensive plan. They also can have transit modeling incorporated into the model. Special household surveys are frequently made to understand travel behavior within the urban areas. Other special data collection efforts that can be made include origin-destination surveys. Therefore the development time for these models range from several months to several years. Complicating the development of these MPO TDMs is the scale of the model which might span several counties. This multi-county area requires elaborate coordination for data collection efforts and even agreement upon model parameters/assumptions. The network for the KIPDA model is shown below:

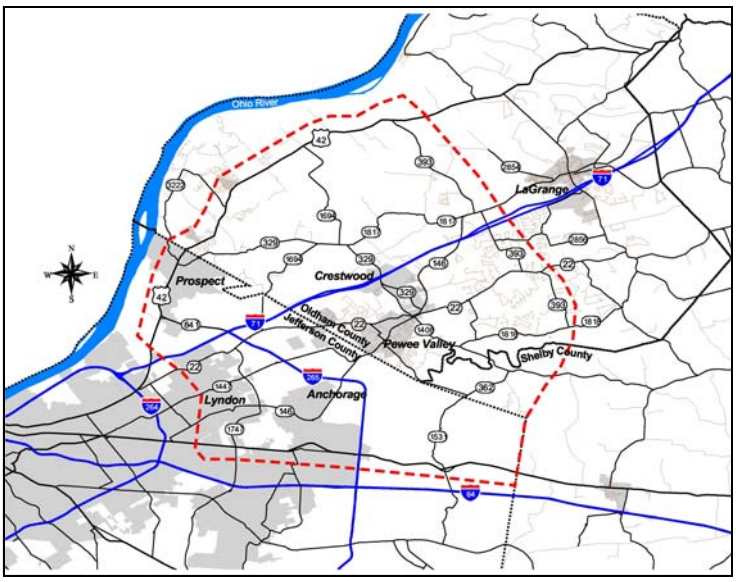


- **The Kentucky Statewide Traffic Model**. The Kentucky Statewide Traffic Model (KySTM) is a large regional model that is primarily used for traffic forecasting purposes in corridor studies. The most prominent usage recently has been for statewide studies involving various I-66 projects. The KySTM has also been used as a source for external trip patterns for county-level models and has been used to optimize the locations of commercial vehicle monitoring stations (weight stations). The KySTM uses data from many varied sources including the Nationwide Personal Transportation Survey (trip rates and trip lengths), Reebie data (freight origin-destination data), origin-destination data (mostly from Ohio), Census Transportation Planning Package (CTPP) data, and from the national planning model. This model undergoes frequent minor updates and will have a major upgrade in the near future using new 2000 census data. The development time for this model varies but is usually at least two years. The graphic depiction of the KySTM network, which spans ten states, is shown below.



- **Small urban area models**. Small urban areas have a population between 5,000 and 49,999 (a list of Kentucky's small urban areas and available models is on the web at http://www.kytc.state.ky.us/Multimodal/xls/SUAstudyupdatefile/) These models usually involve special data collection efforts (traffic counts, population and employment projections). The model is used to help develop a long-range transportation improvement plan for the area. The models can also be used for traffic forecasting and air quality analysis purposes. The model development typically takes six to 12 months. These models have a similar scope to the county-level models but vary on the level of effort used and the intended uses (more uses for SUA models than county-level models). The graphic below is of a recent model network developed for Bowling Green, which shows traffic bandwidths.

- **Special Models** are used for one-time studies. The most frequent special models involve creating a subarea model from a larger model or making many modifications to an existing model for a project such as I-66. The dashed line shows the subarea model area created for the Crestwood Connector project in Oldham County in the graphic displayed below:



How long does it take to build a travel demand model?

As mentioned in the section above the development of a travel demand model can vary from a minimum of four months for a simple model to several years for a very complex model. Development costs can range from about $30,000 to several hundred thousand dollars.

How accurate are travel demand models?

Travel demand models used several tools to assess the accuracy including root mean square error (RMSE), screenlines and vehicle miles traveled by functional class. All of these tools compare existing traffic volumes to assigned volumes and determine if the model falls within an acceptable error range. Typically, the Cabinet accepts about a 30% RMSE for SUA models and about 50-70% RMSE for statewide modeling. The total VMT is expected to be very accurate (less than 5% error) and is controlled by adjusting the trip rate. It must be stated that the future models have less accuracy due to uncertainty about the future. Nevertheless, TDMs are the best tool available to assess traffic conditions 20-30 years from now. The accuracy of the TDMs is dependent upon accurate data and skilled practitioners.

What data are needed for travel demand modeling?

TDMs are very data intensive and there is a direct relationship between the quality of the data and the quality of the model. The major data requirements include:

- **Traffic data,** especially volume data on each link and vehicle classification at the external stations. KYTC's Division of Planning provides excellent traffic data at http://www.kytc.state.ky.us/planning/**.**
- **Socioeconomic data** or population and employment data, is vital to generate travel data at the zonal level and for future tripmaking. Population data is available from the State Data Center: http://cbpa.louisville.edu/ksdc and employment data is available from the Department of Employment Services and commercial databases.
- **Travel behavior data** from household surveys or transferable data from the Nationwide Personal Transportation Survey is important for understanding the purposes of trips and determining accurate trip patterns from zone to zone. NPTS data is available from the Bureau of Transportation Statistics at http://www.bts.gov/.
- **Land use data,** and especially land use projections, are important to assist in making projections into the future. This data is typically obtained from county comprehensive plans, the Area Development Districts, and the Highway District Offices.
- **Highway data,** such as geometric and operation data, is critical for building an accurate model network. In Kentucky, excellent data is available from the Highway Information System (HIS) database.

What software is used to perform travel demand modeling?

There are many commercial packages available for doing travel demand modeling. KYTC has used MinUPT for many years and is in the process of transitioning to TransCAD. TransCAD has the advantage of having a built-in geographic information system (GIS) along with many other traffic engineering utilities.

What is the Traffic Model Users Group?

The Traffic Model Users Group is a group that meets periodically to discuss travel demand modeling and related modeling issues. Due to travel demand modeling having a regional scope, this group serves to accomplish technology sharing and facilitate training in Kentucky and nearby areas. The group has been in existence for seven years and meets about three times per year. An annual workshop on a timely topic is always a key ingredient of the MUG. Some topics that have been discussed at MUG meetings include:

- Travel demand modeling software developmen;
- Travel demand modeling data needs including traffic counts, household surveys, origin-destination surveys, and socioeconomic data;
- Freight modeling;
- Traffic simulation modeling;
- Air quality analysis and modeling including Mobile 6.0;

- Speed estimation; and
- Case studies of state-of-the-art travel demand models.

The MUG has had participation from many other states and members include representatives from state departments of transportation, the Federal Highway Administration, the consulting industry, local universities, and other interested individuals. The MUG serves as an effective way to disseminate information, to reach consensus on controversial issues and to improving the local/regional TDM state-of-the-art.

It is governed by a steering committee of two KYTC representatives and two people from the private consulting engineering industry. The web site for that group is: http://www.kytc.state.ky.us/Multimodal/KyTraffic_MUG.htm.

Can you explain some of the technical terms?

As with most transportation engineering enterprises, there are many technical terms that need clarification. Some modeling jargon (borrowing heavily from the **Statewide Travel Forecasting Workshop Manual** written by FHWA) follows:

- **Four Step Models** are the traditional traffic demand models used today. They consist of trip generation, trip distribution, modal split and traffic assignment.
- **Networks** are depictions of the highway system. They are composed of links, centroids, centroid connectors and nodes and serve to facilitate travel between TAZs. A model network typically has all of the state-maintained roads and a handful of local roads. Networks also contain most of the model information such as existing traffic data, lengths, speeds, capacity values, functional class and many other data items.
- **Traffic Analysis Zones (TAZs)** are based on census subdivisions and are the building blocks for the model. Most of the travel consists of trips being produced in one TAZ and being attracted to another TAZ. A smaller number of trips stays in the TAZ and are known as intrazonal trips.
- **Trip Generation** determines the total number of person trips that begin or end in a zone.
- **Trip purposes** are a means to group trips that have similar characteristics. Examples of trip purposes include home based work trips, home based other trips and non-home based trips.
- **Trip Distribution** finds the number of person trips that go between all pairs of zones. The gravity model is the technique used to accomplish this in all of Kentucky's models. The gravity model is based on observations that there is a relationship between travel propensity based on the size of pairs of zones and based on the distance between the zones.
- **Modal Split** is a major step of traffic demand modeling when transit is involved. Most of KYTC's models do not contain a modal split step. Modal splits are usually accomplished using logit models.

- **Trip Assignment** is the step to assign the model trips generated in the TAZs to the network. Assignment algorithms include all or nothing, capacity restrained equilibrium and stochastic. All of these are based to some extent on the theory that traffic finds the shortest path (in time or cost) between two points. Kentucky's models produce 24-hour assignments.
- **Calibration** is the adjustment of model parameters to known travel behavior. In Kentucky, the term calibration is used for the industry practice of validation.
- **Validation** involves the comparing base-year forecasts to known traffic levels.
- **Traffic forecasting** consists of producing base year and future year estimates of travel for planning, highway design and other purposes. The Traffic Forecasting FAQ brochure describes traffic forecasting in greater detail.
- **Air quality analysis** is accomplished with model output – VMT and speeds – to determine the impact of highway changes upon air quality. The VMT is usually linked to emission factors for various pollutants in order to gauge air quality impacts.

Is there more information available about travel demand models?

Yes, KYTC has a basic report on small urban modeling that gives background information entitled **Small Urban Area Travel Modeling Using MinUTP**. KYTC also has extensive documentation of the statewide modeling process and each individual small urban area model that has been developed. The MPOs maintain documentation on their own models.

Further information about travel demand modeling practice nationally is available through the Transportation Model Improvement Program (TMIP) http://tmip.tamu.edu/. TMIP is FHWA's official modeling entity and provides training, a listserve and extensive documentation. **NCHRP Report 365** is also a major source of information about travel demand modeling.

For further information about the Kentucky Transportation Cabinet's travel demand modeling function, contact the Division of Multimodal Programs at 502-5645-7686 or browse the web page at: http://www.kytc.state.ky.us/Multimodal/index.htm .